DOCUMENT RESUME

ED 264 122 SE 046 284

TITLE	Whales of New England. Secondary Curriculum.
INSTITUTION	New England Aquarium, Boston, Mass.
PUB DATE	85
NOTE	25p.
AVAILABLE FROM	New England Aquarium, Central Wharf, Boston, MA 02110 ($3.00).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Animal Behavior; *Animals; Experiential Learning; Field Instruction; *Field Trips; *Marine Biology; *Outdoor Activities; *Science Activities; Science Education; Secondary Education; *Secondary School Science; Wildlife
IDENTIFIERS	Aquariums; *Whales

ABSTRACT

Instructional materials and suggestions for conducting a whale watching field trip are contained in this curriculum packet for secondary science teachers. It is one unit in a series of curricular programs developed by the New England Aquarium Education Department. Activities and information are organized into three sections: (1) pre-trip activities (providing fact sheets on cetaceans, worksheets on specific whales, and a vocabulary list); (2) trip activities (including descriptions of cetacean behaviors and a data sheet for recording observations); and (3) post-trip activities (identifying project areas and suggesting enrichment experiences). Preparatory and follow-through instructional strategies are offered and a list of resources is also provided. (ML)

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Whales of New England

Secondary Curriculum

ED264122

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for teachers:

Thank you for planning a whale watching trip with the New England Aquarium. This packet is designed to help you and your students make the most of this unique field trip and assist you in extending the learning into your classroom.

In this packet you will find:

- General information on cetaceans
- Information on Stellwagen Bank, our trip destination
- Fact sheets on humpback and finback whales
- Information on the feeding behavior of whales
- Humpback whale fluke match-up sheet
- Cetacean data collection sheet and teacher's guide
- Suggested activities/projects
- Vocabulary list
- Bibliography

An important point to remember about a trip on the water is that you will be exposed to unpredictable weather: sun, clouds, rain, and rapid temperature changes. You can also be sure that the temperature on the open sea will be considerably colder than the temperature on land. Please be sure that your students are prepared by wearing or bringing the following:

- Waterproof windbreaker and heavy sweater, down vest or jacket
- Boat shoes, boots, non-skid shoes with warm socks
- Wool hat and gloves
- Dark glasses, sun cream

For your comfort, we strongly suggest that those in your group who have not been to sea before, or who have experienced seasickness in the past, obtain medication and follow the directions on the label. (Most directions suggest taking medication at least one hour before sailing. A good breakfast also helps prevent motion sickness.) It pays to take preventative measures, as most medications will not be effective once someone is ill.

If you have any questions about your upcoming whale watching trip, or this curriculum packet, please contact the New England Aquarium at 742-8830, ext. 295.

Sincerely,

Cindy Richardson

Cindy Richardson
Education Department

New England Aquarium

1

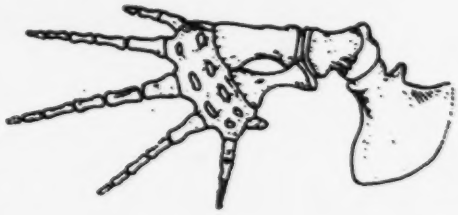
pre-trip activities

cetaceans 1

Cetaceans are mammals that are adapted to the ocean environment. All whales, dolphins, and porpoises are cetaceans. Like other mammals they are ■ warm blooded ■ give birth to live young ■ nurse their young ■ breathe air through lungs and ■ have hair at some time in their development.

Studies of living and fossil cetaceans suggest that these animals may be descended from land mammals. Over millions of years their bodies have undergone many physical changes. Their fore limbs have evolved into flippers which are used for steering and stabilization. The bone structure in these flippers is very similar to that of our own hand. The hind legs have all but disappeared from the whale's body. Today, all that remains of these limbs is a pair of small bones, deep within the body tissue, located about where the hind legs of a land mammal would be found. The cetacean's tail has evolved into the major means of locomotion, with wide flukes made of tough connective tissue used for propulsion and steering. Their breathing mechanism has also changed dramatically in the course of cetacean evolution. Millions of years ago the nostrils of whales were probably located in the front of their faces, like those of land mammals today. However, over the years, their nostrils, located in a structure called a blowhole, have migrated to the top of the animal's head. As a result, a whale can continue swimming as it breathes through its blowhole, since only the top of its head must break the surface of the water.

Whale skeleton showing remains of hind limbs.



Close-up of bone structure of whale's front flipper.

There are over 70 species of cetaceans, which are divided into two groups:

1. Toothed whales (Odontocetes)
2. Baleen whales (Mysticetes)

Baleen

Odontocetes, or toothed whales, include dolphins, porpoises, narwhals, orcas (killer whales), beluga whales, and sperm whales. These whales are equipped with cone-shaped or spade-shaped teeth which are used for catching prey.

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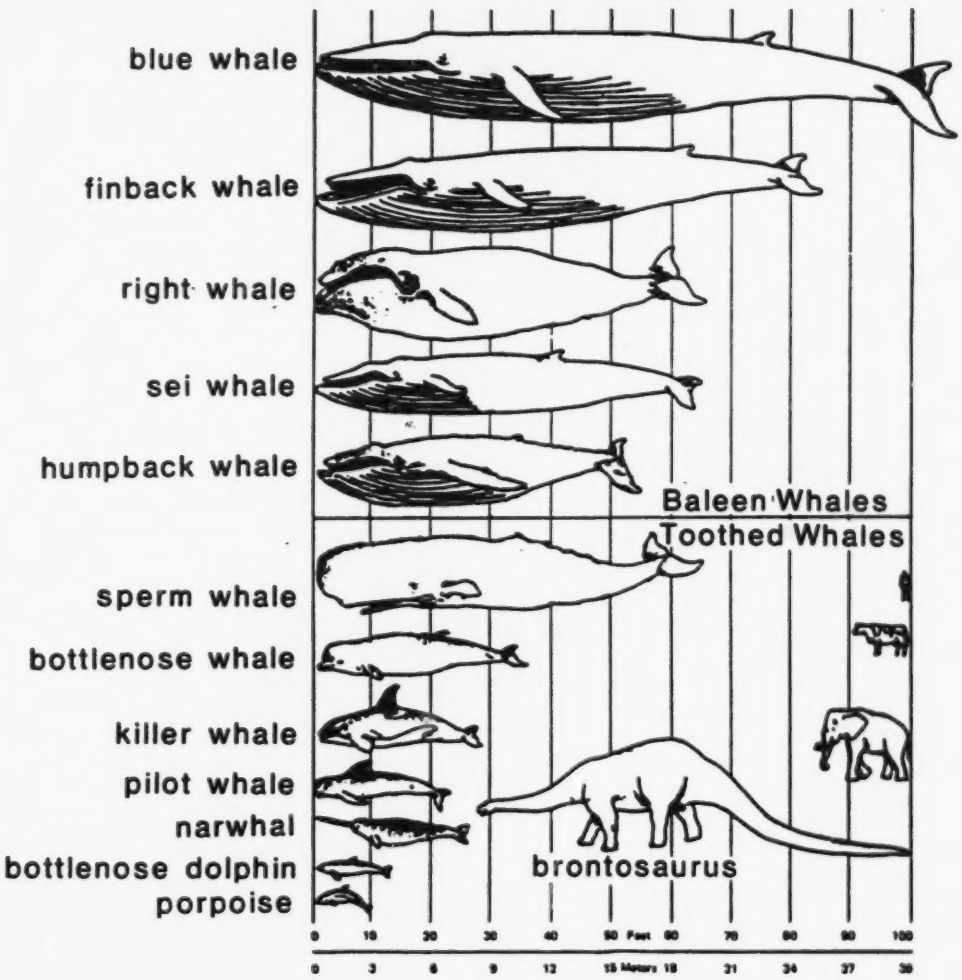
cetaceans 2

Mysticetes, or baleen whales, have no teeth. Instead, their mouths are lined with a series of horny, fringed plates called baleen. These baleen plates enable the whales to strain food, such as fish and krill, (small shrimp-like crustaceans), from the water. Right whales, blue whales, humpback whales, and fin whales are baleen whales.

size comparison chart



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fact sheet: humpback whale

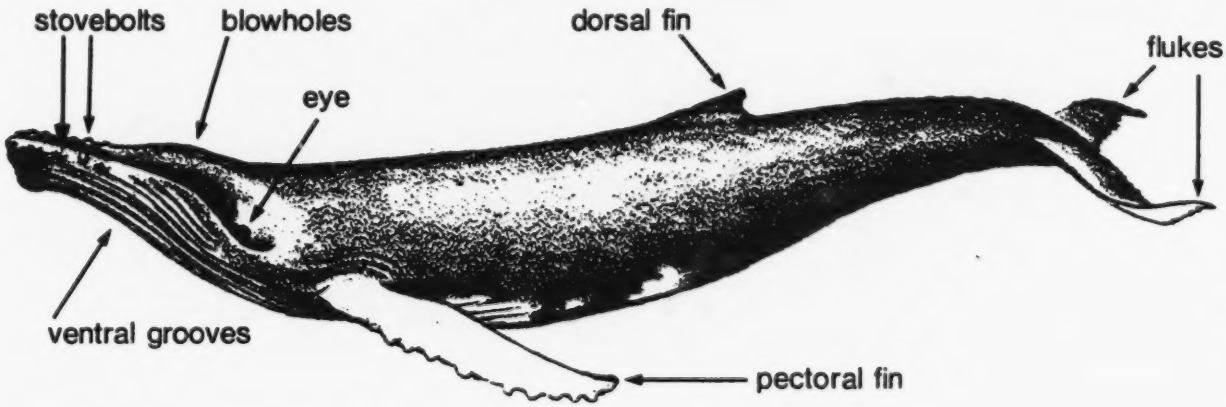
HUMPBACK WHALE (Megaptera novaeangliae)

Adult length: 48 feet
Adult weight: 50 tons
Distribution: Worldwide
Estimated Western North Atlantic Population: 2,500-3,000
Diet: Fish and krill
Gestation Period: 11-12 months

The humpback whale is perhaps the favorite whale of New England whale watchers. It has long white pectoral fins, or flippers, a distinctive characteristic which inspired the Latin name, Megaptera novaeangliae, or large-winged New Englander. A humpback whale's head is covered with hitchhiking barnacles and knob-like bumps referred to as "stovebolts." These "stovebolts" are actually large hair follicles, each containing a single hair.

Humpbacks are probably best known for their acrobatic behaviors. They have been seen rolling on the water's surface, holding one or two flippers out of the water (flipper wave), slapping the water with their flippers (flipper slap) or tail (lobtailing), or lifting their bodies out of the water (breaching).

At the start of a deep dive, the humpback arches its back dramatically and often lifts its tail, or flukes, out of the water as it descends. The pigment pattern on the underside of the flukes is unique for each whale, and, like our fingerprints, may be used to identify individuals. Scientists have photographed and catalogued over 2,500 humpback whales in the western North Atlantic, and have begun to collect information on their migration patterns through this identification process.



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fact sheet: finback whale

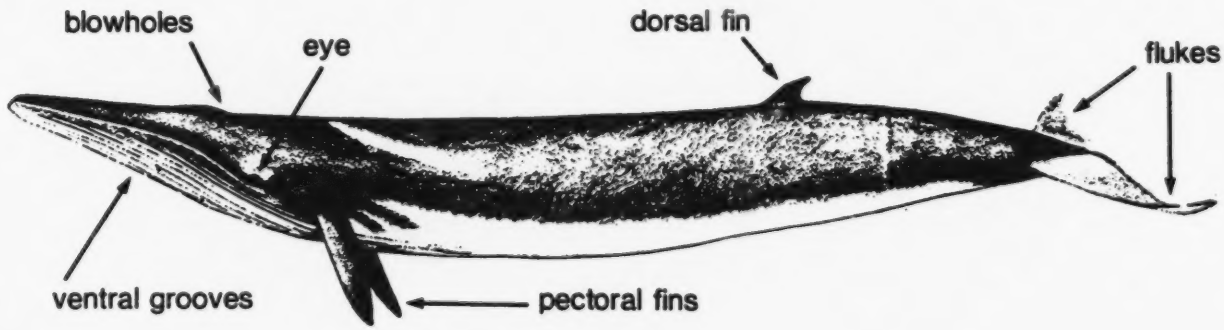
FINBACK WHALE (Balaenoptera physalus)

Adult Length: 60-70 feet
Adult Weight: 60-70 tons
Distribution: Worldwide
Estimated Western North Atlantic Population: 7,200-10,000
Diet: Fish and krill
Gestation Period: 12 months

The most common large whale in the Gulf of Maine is the finback whale. Second in size only to the blue whale, a finback may reach a length of 70 feet. Because of its streamlined shape and swimming speeds up to 20 mph, it is sometimes called the "greyhound of the sea."

As its name suggests, this whale has a prominent dorsal fin. The most unique field mark for this whale, however, is the uneven coloration of the lips and baleen. On the left side, both the lips and baleen are dark; on the right side, the lower lip, the first third of the baleen, and sometimes the upper lip, are white or pale gray. The reason for this asymmetric coloration is not known. Some scientists theorize that it may be used in feeding, to herd or startle prey. Or perhaps the reverse, to camouflage the whale as it hunts.

Finback calves are born in winter. The newborn whales are about 20 feet long and nurse for 6-8 months. Mother whales may provide calves with as much as 100 gallons of milk per day. By the time they are weaned, the calves may be 36 feet long.



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fact sheet: right whale

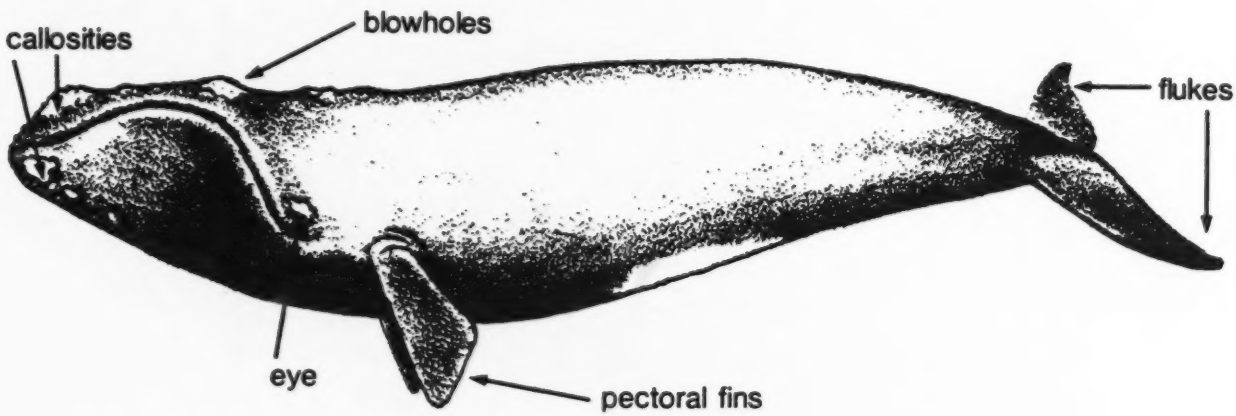
RIGHT WHALE (Eubalaena glacialis)

Adult Length: 35-50 feet
Distribution: North Atlantic from the Gulf of St. Lawrence to Florida
Estimated Population: 200 animals
Diet: Planktonic copepods and other small crustaceans
Gestation Period: 12 months

Due to overhunting, primarily during the 17th and 18th centuries, the right whale is one of the most endangered whale species. Because of their high yield of oil and baleen, and because they were slow swimmers and floated when dead, they were highly prized by whalers. In fact, the name right whale was given to this species because whalers considered them to be the "right" whale to kill.

Although right whale sightings are somewhat rare, the species can be easily identified by several field marks. These include broad, smooth flukes, the absence of a dorsal fin, and unusual light-colored, wart-like growths on the head, upper jaw, and around the blow hole. These "callosities" and the patterns they form have been used to identify individual right whales.

The New England Aquarium has been studying right whales in the Bay of Fundy for 3 years. Our investigations have focused on the behaviors of these animals, as well as researching what appears to be a critical habitat for the remaining right whale population in the North Atlantic.



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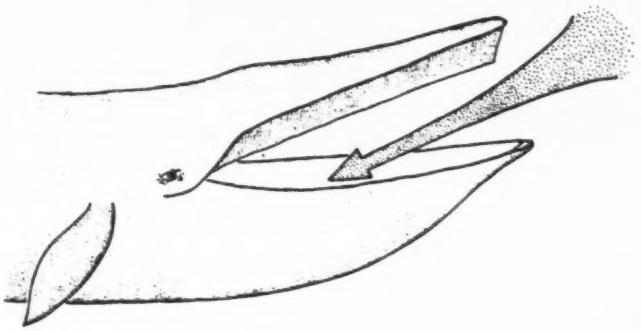
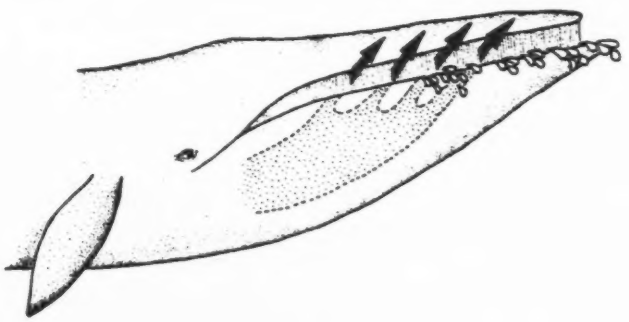
feeding behavior

Baleen whales feed by filtering or straining food from the water. Some, such as the right whale, are called "skimmers". These whales swim slowly with their huge mouths open to take in large amounts of water and food. The water flows into the mouth and back out through the baleen, while the food is trapped in the fringed inner edges of the baleen plates.

Other baleen whales may pursue their food more actively by lunging through a school of fish with their mouths open. They gulp large volumes of water and food in each lunge. The sea water flows out through the baleen plates and the fish are trapped inside the whale's mouth and swallowed. Whales that feed in this manner, such as the finback and humpback whales, are called "gulpers".



Many "gulpers" are also known as "rorquals". This name refers to the folds or grooves located on the throat and chest of whales such as the finback, minke and humpback. The name rorqual comes from the Norwegian words: "ror" meaning tube, and "hval" meaning whale. These ventral grooves play an important role in feeding. When a rorqual whale gulps a mouthful of food and water, the grooves stretch like accordian pleats. This expands the throat and allows the whale to take in an enormous amount of food and water with each gulp.



Humpback whales sometimes trap their prey in a more unusual fashion by "bubble feeding." The feeding whale dives under the water and exhales a large amount of air underneath a school of fish. This "bubble cloud" seems to startle fish and sends them to the surface as the air rises. The whale then swims up through the bubbles with its mouth open to engulf its prey.

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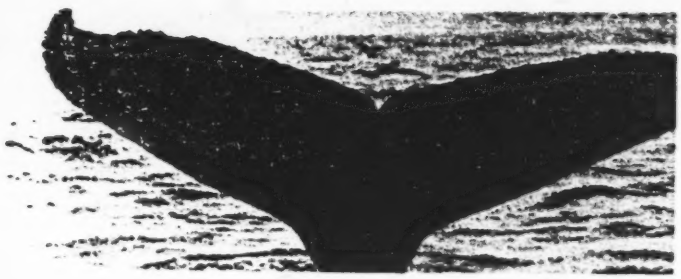
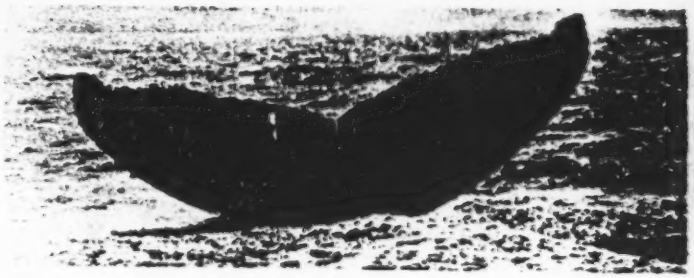
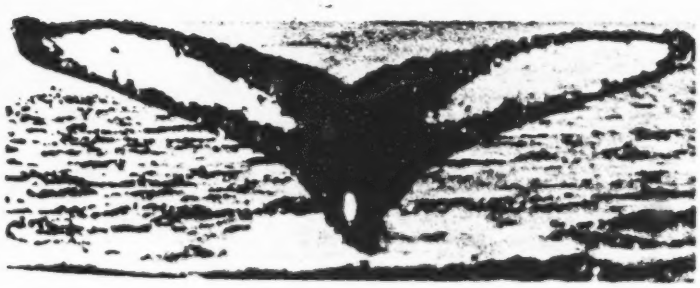
worksheet:

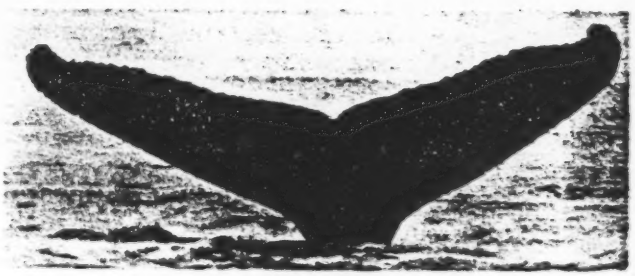
HUMPBACK WHALE FLUKE MATCH-UP SHEET

Individual humpback whales can be identified by the unique pigment pattern on the underside of its flukes. These patterns may range from almost all black to practically all white. No two whales have the same pattern. The photographs on this page were taken from a catalog which contains hundreds of whale fluke photographs. Can you match the two photographs of the same whale?









stellwagen bank

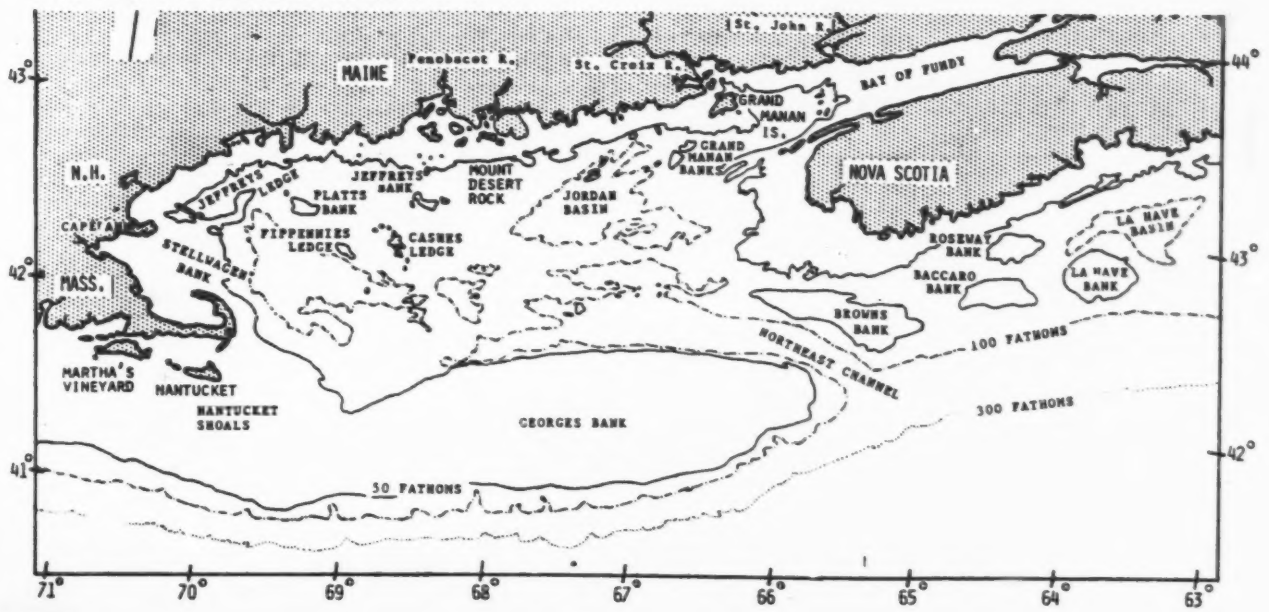
The Gulf of Maine is the large body of water that stretches from Cape Cod to Nova Scotia and includes such rich fishing areas as Georges Bank. Within Cape Cod Bay, whales are commonly sighted on Stellwagen Bank, a smaller bank about 27 miles east of Boston.

Why do whales visit Stellwagen Bank? This shallow area is a feeding ground rich in plankton and fish. The high productivity is due in part to a process called upwelling. Upwelling occurs when deep offshore currents strike submerged ledges and banks and are forced to the surface. The water that rises from these depths is rich in nutrients. When it reaches the sunlit surface, it enhances conditions for phytoplankton growth and fuels the base of an ocean food chain. Because of the abundance of plankton and fish on Stellwagen Bank, whales are often sighted here, feeding in the fertile waters.

The humpback whales of the Western North Atlantic spend their winters in the warm waters of the Caribbean. There they breed and bear their young. As spring approaches, adults and calves begin their migration to the whales' northern feeding grounds. Along the route the whales separate, some traveling as far north as the waters of Greenland and Newfoundland. Whales can be found on Stellwagen Bank in large numbers from early spring to mid-October. In fact, some whales may spend their entire summer off the Massachusetts coast.

At least 21 species of whales have been recorded in the area of the Gulf of Maine. However, the most commonly sighted on Stellwagen Bank are two large baleen whales: the finback and the humpback

chart of the Gulf of Maine



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vocabulary 1

Baleen	Horny plates suspended from either side of the roof of a baleen whale's mouth. The frayed inner edges of the baleen plates filter plankton and small fish from the water for food. Also called whalebone.
Blow	The explosive burst of air exhaled by a whale on surfacing. This exhaled breath is often visible as a spout which is probably caused, in part, by the change in pressure as the air is forced from the blowhole. The warm moist breath which condenses as it encounters the cold sea air may also account for the visible spout. Small amounts of water covering the whale's blowhole as it surfaces may also help to give the blow its misty appearance.
Blowhole	A whale's nostril, located at the top of the animal's head. Toothed whales have one blowhole opening; baleen whales have a double blowhole.
Blubber	Blanket of fat and fibrous tissue under the skin of whales which provides warmth and energy storage.
Calf	The young of a whale, dolphin or porpoise.
Cetacean	A member of the order Cetacea, including whales, dolphins and porpoises.
Chevron	A field marking of the finback whale which consists of two pale stripes beginning behind the blowhole openings and running along the animal's back and upper sides forming a broad "V".
Dolphin	A small toothed whale. The names dolphin and porpoise are commonly used interchangeably, although dolphins have pointed, cone-shaped teeth, in contrast to the spade-shaped teeth of porpoises.
Dorsal fin	Back fin. This acts as a stabilizing fin which may help to prevent whales from rolling from side to side.
Flipper	See pectoral fin.
Fluke	The horizontal tail fin of a cetacean.

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vocabulary 2

Krill	A shrimp-like crustacean which is consumed in large numbers by some baleen whales.
Mysticetes	Sub-order of cetaceans referred to as baleen whales. From the Greek "mystax", meaning moustache and "kelos", meaning whale.
Odontocetes	Sub-order of cetaceans referred to as toothed whales. From the Greek "odontos", meaning teeth and "kelos", meaning whale.
Pectoral fin	Side fin or flipper. On cetaceans these fins act as stabilizers or are used for steering.
Plankton	Free-floating or drifting aquatic plants or animals which provide the base of the ocean food chain.
Pod	A social unit or "school" of whales, also called a herd or a gam.
Porpoise	A small toothed whale with spade-shaped teeth. See dolphin.
Rorquals	Name given to some baleen whales by Norwegian whalers. The name comes from the Norwegian words "ror", meaning tube, and "hval", meaning whale, and refers to the ventral grooves on the animal's throat and chest.
Sounding	Old whaler's word for a whale's dive.
Ventral grooves	Folds on the throat and chest of some baleen whales. These grooves distend to allow the whale's throat to expand during feeding.
Whalebone	See Baleen.

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2

trip activities

cetacean data sheet

Select one whale during your whale watch with the New England Aquarium. Collect the following data:

Date of sighting: _____

Time of sighting: (start) _____ (stop) _____ Total duration: _____

Describe weather conditions - Estimate wave height and air temperature:

_____

_____

Describe shape and height of blow: _____

_____

Species: _____ Estimated body length: _____

Average time at surface between dives: _____

Average length of dive time: _____

Alone or with other whales? _____

Describe behavior: _____

_____

_____

_____

_____

_____

If you are observing a humpback whale, is the fluke pattern visible?
If yes, describe coloring, any scars, or other markings:

_____

_____

_____

If possible, photograph or sketch the fluke pattern.

If you are observing a fin whale, is the white lip coloration visible on the right side of the head? Is the chevron visible?

Other comments or observations_____

_____

_____

Questions to think about:

1. What kind of information do you think is useful to whale researchers? Why?

2. Can any conclusions be drawn about whale behavior based on your observations?

3. What are some of the difficulties and limitations facing whale researchers?

cetacean behaviors

Breach	An acrobatic behavior in which the whale lifts its body out of the water, twists, and falls back into the water with an enormous splash.
Blow	The exhalation of a whale.
Bubble Clouding	A feeding behavior that is sometimes observed in humpback whales. The whale dives below the surface and exhales, producing a cloud of bubbles which rises to the surface. This seems to startle fish and drives them to the surface as well. The whale swims up through the cloud with its mouth open to feed.
Flipper slap	Slapping of a flipper or pectoral fin on the water's surface.
Flipper wave	Holding one or two flippers or pectoral fins out of the water.
Fluking up	Raising the flukes out of the water when making a longer or deeper dive. When observing humpback whales, this is the time to try to take photographs of the pattern of the underside of the flukes.
Lobtailing	Slapping the tail and flukes on the surface of the water.
Lunge feeding	A feeding behavior in which the whale lunges on the surface of the water with its mouth partially open to trap food.
Spyhopping	The vertical movement of a whale out of the water, usually to just above its eye level. The whale holds this position with its head upright in the air.
Terminal dive	The final dive in a series. Frequently whales will make several shallow or short dives, coming up for a breath between each one. On the terminal dive, a whale arches its back, some may lift their flukes out of the water, and makes a deeper or longer dive. On a terminal dive the whale may remain under the water for five minutes or more.

for teachers:

CETACEAN DATA SHEET TEACHER'S GUIDE

The New England Aquarium collects data on the whales sighted during our whale watching trips. This information is compiled, studied, and shared with other researchers in the field.

The Cetacean Data Sheet included in this packet may be used by your students to collect their own whale data. It is hoped that this activity will give them new insights into whale research.

The effectiveness of such an activity depends largely on preparation and follow-up in the classroom. The following information may be helpful to you if you plan to include this activity in your students' study of whales.

In order to complete the activity, your students will need:

- a pencil
- a clipboard
- Cetacean data sheet
- a watch

Prior to the whale watching trip, students should read the data sheet and the accompanying whale behavior list so that they are familiar with both.

Three "Questions to think about" are included at the conclusion of the the data sheet. The first of these might provide the focus for a pre-trip discussion:

1. What kind of information do you think is useful to whale researchers? Why?

All of the information on the data sheet provides valuable data for a researcher. Specifically...

- Date and Time help to pinpoint the specific observation that was recorded. The location of the sighting is also crucial information for a researcher. However, since your students may not have access to this information, it was not included on this form.
- Information on weather conditions also helps the whale researcher, particularly if he or she is trying to identify patterns between whale behavior and environmental conditions, such as wave height, air temperature, and water temperature. When examining the data sheets following a trip, the researcher may also want to recall the extent of visibility for that

particular day. Weather conditions certainly affect the ease with which whales can be observed.

- Spouting, usually the first sign of a whale in the distance, can be an accurate field mark in identifying whales. Some whales, such as the finback, have a tall, thin spout, or blow. Others, like the humpback, generally have a shorter, bushy spout.

- The species of the animal observed, as well as its estimated size would obviously be important items in the data collection. Although it is very difficult to determine the age of a whale, size may be related to age.

- Time at the surface/Time during dives. Comparing the time a whale is on the surface to the time spent during dives can tell an observer much about the general activity level of the whale. It should be mentioned to the students that the information we have about whales is generally collected when the animals come to the surface to breathe. We seldom get a glimpse of the other part of their life, under the water's surface. By studying dive time and surface time we may better understand whale behavior. Are there any patterns that can be observed?

- Alone or with other whales? Little is know about the social behavior of whales. Cow/calf pairs are sometimes observed, we frequently sight solitary whales, and ocassionally see a pair or small group of seemingly unrelated whales. Recording information about how whales group themselves may help us to better understand their social structures.

- Behavior. A variety of behaviors may be observed on a whale watching trip. I have included a list of common whale behaviors and the terms researchers use to describe them. It would be useful for students to review this list, or even have a copy on their clipboard while data collecting. It should be stressed, that when completing the data sheets, the students must list and describe the behaviors in the order they occurred. The sequence of behaviors is of as much value as the recording of the behaviors themselves.

- Special markings/fluke patterns. If your students are able to photograph the underside of a humpback's fluke, it may be possible to identify that individual whale. This is done by comparing the photograph to other fluke photos of known whales and trying to find a match. (See fluke match-up sheet in this curriculum packet.)

The second and third questions on the Cetacean Data Sheet might be used for a class discussion following the whale watching trip:

2. Can any conclusions be drawn about whale behavior based on your observations?

It is difficult to draw any specific conclusions based on one whale observation. Whale researchers study whales day after day, year after year, before they begin to see patterns emerging from their data. It is only then that they begin to hypothesize about what whales do and, even more difficult, why they do it. The fact of the matter is that we still have much to learn about whales.

3. What are some of the difficulties and limitations facing whale researchers?

Whale research is plagued by difficulties and limitations! One, which has already been mentioned, is the fact that we can only observe whales when they come to the surface to breathe. Much of their activity below the surface remains hidden from us. Frequently, when scientists want to study animal behavior, they observe animals, not only in the wild, but also in captivity. Whale researchers do not have this option. They are unable to study the large whales in a captive environment. Also, since the whales usually move faster than the researcher's boat, observations are dependent on the whale staying nearby. A whale that dives deeply, and then surfaces five minutes later out of the researcher's view, only makes the job even more difficult. And finally, although we know the general areas where whales can be found during certain times of the year, we cannot predict their exact location from one day to the next. In New England waters the whales follow their food supply, as the fish move so do the whales. The challenge to the whale researcher, as well as the whale watcher, is to try to anticipate these movements as much as "humanly" possible.

3

post-trip activities

activities

Research	Research information on the songs of the humpback whale. Or on the anatomy of echolocation. Or the physiology of diving in cetaceans.
Debate	Compile a list of nations currently involved in whaling. What are whale products used for? What modern whaling techniques are employed? Stage a debate on the pros and cons of modern day whaling.
History	Study the history of whaling in New England. How did this industry affect the growth and development of New England's seaports? Compare modern-day whaling technology with that of the 1700's and 1800's. Good sources of information and field trip sites: Kendall Whaling Museum, Sharon, MA; New Bedford Whaling Museum, New Bedford, MA; Peabody Museum of Salem, Salem, MA.
Conservation	What are the current laws and regulations governing the whaling industry today? What is the Marine Mammal Protection Act? For information, contact: Doug Beach National Marine Fisheries Service Northeast Regional Office Federal Building 14 Elm Street Gloucester, MA 01930 Richard Roe Office of Protected Species National Fisheries Service Washington, DC 20235
Migrations	On a large world map, locate areas where humpback whales are found. Chart the proposed migration route of the Western North Atlantic population, specifically noting the winter breeding areas and summer feeding grounds of this population.
Sizes	Using a grid system, make a life-size whale silhouette in your school yard or parking lot (use the size comparison sheet in this packet for approximate sizes).

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